Research Note

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COMPARATIVE EFFECT OF SEED TREATMENTS UPON SEEDLING EMERGENCE IN SEVEN BROWSE SPECIES

Roald A. Peterson
Division of Range Research

INTRODUCTION

Artificial propagation by seed of palatable native browse species may be an economical way of improving big game forage and watershed values. Success of artificial reseeding generally requires that the planted seeds germinate soon after growing conditions become favorable. On the other hand, under natural conditions, persistent and variable seed dormancy may often be a factor favoring survival of a species. Such dormancy is in no way uncommon among native browse and tree species. This adaptation, however well geared to the timeless regime of nature, presents an obstacle to efficient artificial seeding of these refractory native species. It can be overcome only by learning the processes for unlocking the seed dormancy peculiar to each species. This paper presents effects of comparable seed treatments upon seedling emergence of seven browse species potentially important in the improvement of big game ranges and control of erosion throughout much of the northwest mountain region.

Results from the tests show the extreme importance of proper seed treatment of these browse species if germination is to be hastened, and what some of the effective treatments are for each species. Most of the data support results from other studies, thus strengthening the base for generalizations. In a few instances, contradictions point up the need for more investigations.

COLLECTION AND PREPARATION OF SEEDS

Seeds of the seven browse species -- redosier dogwood, *Cornus stolonifera* Michx, antelope bitterbrush, *Purshia tridentata* (Pursh) DC, redstem ceanothus, *Ceanothus sanguineus* Pursh, snowbrush ceanothus, *C. velutinus* Dougl., Saskatoon serviceberry, *Amelanchier alnifolia* Nutt., western chokecherry, *Prunus demissa* (Nutt.) Walp., and Rocky Mountain maple, *Acer glabrum* Torr. -- used in this study were collected in Lincoln County in northwestern Montana by Jack Schmautz and Ade Zajanc, formerly of the Montana State Fish and Game Department. Bitterbrush seeds were collected in July, the others in the second half of August. Chokecherry and serviceberry seeds were depulped by hand using water and screens. All seeds were stored in an unheated shed for about three months and then at room temperature for one and one-half months. Before testing, each seed was inspected carefully, and those which showed abnormalities or defects were discarded.

TREATMENT OF SEEDS AND TEST CONDITIONS

Five seed treatments were tested (Table 1). Three were applied to all species, while Rocky Mountain maple and western chokecherry seeds were not scarified.

Table 1. Seed treatments used in this study

Treatments	Species	Duration of treatment
Exposed to winter conditions only	All species	87 days
Scarified and exposed to winter conditions	All except western chokecherry and Rocky Mountain maple	87 days
Stratified only	All species	90 days
Scarified and stratified	All except western chokecherry and Rocky Mountain maple	90 days
Submerged in hot water and stratified	All species	(30 minutes (90 days

Except for redstem and snowbrush seeds which were carefully punctured with a dissecting needle, all scarification was done by rubbing the seeds individually over fine sandpaper until the seed coat was worn through. (All seed coat abrading or puncturing, however, will henceforth be referred to as "scarification.") After scarification, the seeds were covered and stored in a refrigerator for three to seven days to keep drying at a minimum before either being stratified or prepared for outdoor exposure. For the hot water treatment 90 cubic centimeters of boiling water were poured over each lot of 100 seeds in a 100cc beaker and allowed to cool at room temperature for 30 minutes.

Seeds exposed to winter condition were planted in well-watered soil flats and set outside on the ground on January 2. Because little snow fell the soil became dry, hard, and cracked before the flats were brought in for germination on April 2. Mean monthly temperatures were about 22, 28, and 37 degrees Fahrenheit for January, February, and March, respectively (4)[1/].

Stratification was accomplished by placing the separate seed lots in sausage casings containing moist, sterilized, fine sand, packed in moist peat, and stored at about 35 degrees Fahrenheit.

Seeds were planted in greenhouse flats containing loam soil previously mixed for uniformity. One hundred seeds of each species were used for each treatment. These 100-seed lots were divided into sublots of 25 seeds each to provide replication. Sublots were planted in individual rows, 3/4-inch deep, between April 3 and 5, except those planted on January 2 for winter exposure.

All flats were placed side by side in the greenhouse and watered almost every day to keep the soil moist. Seedlings were counted the same day each week for seven consecutive weeks. These counts served as the primary criterion for appraising treatment effect on seed germination.

Daily greenhouse temperatures usually ranged between 45 and 80 degrees Fahrenheit, with an average maximum of 79 degrees and minimum of 45 degrees for April, and 83 and 47 degrees, respectively, for May.

At the end of the test period as many ungerminated seeds as possible of each species were recovered from two rows of each treatment by a washing-screening process. The recovered seeds were dissected and classified as to apparent soundness.

[1/] Numbers in parenthesis refer to literature cited.

RESULTS

COMPARISON OF SPECIES

Antelope bitterbrush emerged first after planting (Figure 1). Thirty-two percent of the final total came up during the first week and 80 percent by the end of the second week. Redstem and snowbrush seedlings began to show by the end of the second week, and over 80 percent of the final total were up by the end of the third week. Emergence was at least 95 percent complete for all species by the end of the fifth week.

In general, the treatments which produced the highest percent germination also showed earlier emergence of the first seedlings than treatments producing a lower total germination. For example, in the case of antelope bitterbrush and redosier dogwood, the hot water treatment followed by stratification did not promote emergence. Likewise, the first seedlings from this treatment emerged a week later than those from more effective treatments. Seeds exposed to winter conditions also tended to germinate somewhat later than the others. Such delay would have obvious disadvantages in field plantings, where rapid response to favorable conditions is usually desired.

Redosier dogwood gave the highest percent of seedling emergence irrespective of treatment. Antelope bitterbrush was second, and Saskatoon serviceberry and Rocky Mountain maple responded least (Table 2). Practically no germination of redstem and snowbrush occurred except in the hot water and scarification treatments involving an increase in seed coat permeability plus after-ripening through stratification.

Combining the total percent emerged seedlings with the percent of sound seed remaining at the end of the trial shows the potential germination -- or the percentage which might eventually be expected to produce seedlings (Table 2). By comparing potential germination with emergence one may glean additional insight into the effect of the hastening treatment. For example, although scarification plus stratification produced the highest emergence in both ceanothus species, this treatment, by increasing seed spoilage, gave a potential germination, ranking fourth among the five treatments. In contrast, seeds of these species exposed only to winter conditions produced practically no seedlings but retained a higher potential germination than ceanothus seeds treated differently. This information is of particular value in plantings where prompt germination is not necessarily desired.

The potential germination was deleteriously affected by scarification plus winter exposure in all species so treated. Even winter exposure alone was adverse for antelope bitterbrush and Saskatoon serviceberry. Stratification alone gave the highest potential germination for most species but was ineffective in hastening germination in some cases.

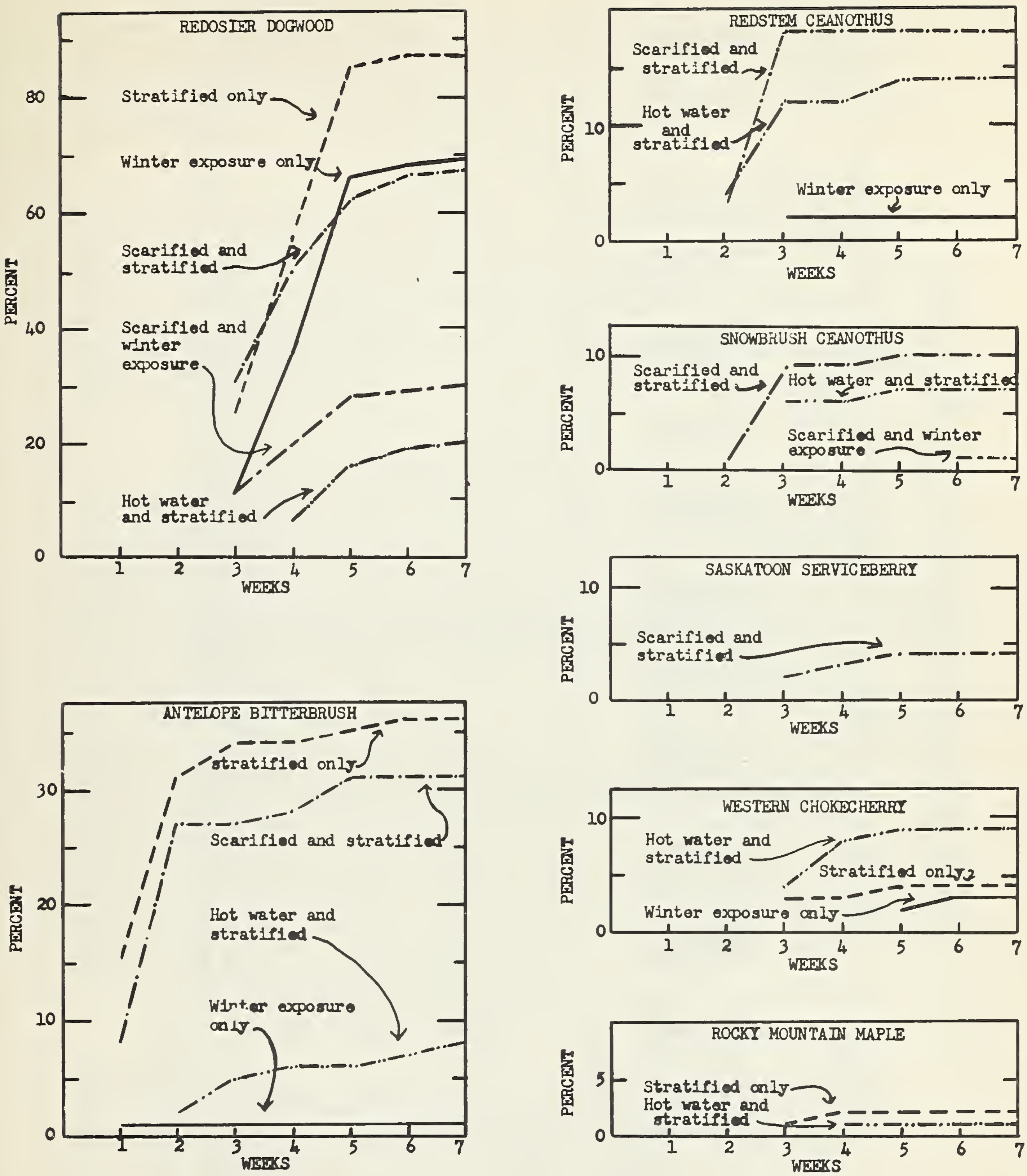

Figure 1. Accumulative seedling emergence for seven browse species relative to treatment of seed. Only those treatments under which emergence occurred are shown for each species.

Table 2. Seedling emergence and potential germination[1] of seed of seven browse species subjected to various treatments

Seed Treatment	Redosier dogwood		Antelope bitterbrush		Redstem ceanothus		Snowbrush ceanothus		Saskatoon serviceberry		Western chokecherry		Rocky Mountain maple	
	Percent emergence	Potential germination	Percent emergence	Potential germination	Percent emergence	Potential germination	Percent emergence	Potential germination	Percent emergence	Potential germination	Percent emergence	Potential germination	Percent emergence	Potential germination
Exposed to winter conditions only	69	83	1	1	2	66	0	88	0	16	3	87	0	72
Scarified and exposed to winter conditions	30	44	0	0	0	0	1	1	0	2	2/		2/	
Stratified only	87	97	36	54	0	38	0	54	0	78	4	92	2	62
Scarified and stratified	67	73	31	35	18	18	10	16	4	38	2/		2/	
Hot water and stratified	20	62	8	32	14	52	7	41	0	72	9	87	1	75

1/ Potential germination is the sum of the percent of emergence and percent of sound seeds remaining at the end of the test. Figures given are conservative, because not all seeds were recovered in each case.

2/ Not given these treatments.

Unlike the mechanical breaking of the seed coat by scarification, which undoubtedly facilitated the entrance of organisms and drying of the winter exposed seeds, the hot water treatment did not cause increased spoilage of seed. Therefore, lots treated in that way usually maintained a high potential germination.

REDOSIER DOGWOOD

With redosier dogwood stratification alone gave emergence which averaged 18 percent higher than the next best treatment. This treatment also gave the best potential germination. Winter exposure alone gave excellent response, but in comparison, scarification of seeds subjected to winter conditions and the hot water treatment plus stratification greatly reduced emergence of seedlings. Potential germination was substantially lower for the seeds scarified and subjected to winter exposure than for those which received other treatments.

ANTELOPE BITTERBRUSH

Stratification without other treatment also gave highest emergence and potential germination in antelope bitterbrush while exposure to winter conditions was poorest. Scarification plus stratification resulted in only slightly lower emergence, but a substantially lower potential germination, than stratification alone. The hot water plus stratification treatment positively inhibited germination, apparently due to the hot water part of the treatment, and the 200 seeds exposed to winter conditions failed to produce more than one seedling.

Both winter treatments resulted in complete spoilage of ungerminated seeds. In contrast, hot water plus stratification and stratification alone left 29 and 36 percent sound seeds, respectively, despite comparatively high emergence. Seventy-four percent of the emerged seedlings "damped-off" by the end of the test. A moderate number died before emergence under all treatments, probably due to the same cause. It seems likely, too, that because some of the seeds germinated while still stratified they may have been injured in planting. This early sprouting points to the importance of keeping the stratification period to less than three months. Two to three months of stratification have been recommended (4).

REDSTEM AND SNOWBRUSH CEANOTHUS

Response of redstem and snowbrush differed slightly in magnitude but was similar otherwise. Scarification plus stratification was the most effective hastening treatment, with hot water plus stratification a close second. Curtis (1), however, reported much higher germination of snowbrush seeds soaked in hot water previous to stratifying than for those abraded by shaking violently with small stones. Based on the experience of this writer this was likely due to the resistance of these seeds to either wear or breakage, which makes scarification difficult. Comparatively, however, the hot water treatment resulted in little seed deterioration or decrease in

potential germination. Low emergence even where the seed coat was punctured suggests that an increase in stratification beyond three months might be desirable. Ready germination of seeds of these species following a fire, after two or more years of dormancy, also indicates that stratification may be prolonged without injury (2).

ROCKY MOUNTAIN MAPLE

Only three seedlings emerged from the 300 Rocky Mountain maple seeds tested. Although a high proportion of the recovered seeds had embryos which were obviously alive and green, they were shrivelled and failed to show growth when placed in moist gauze for one week. No published information was found to explain the poor response of this species. A fall planting, however, in Lincoln County gave germination the following spring of 20.4 percent (3). This suggests that a longer stratification period might help to break dormancy.

DISCUSSION

Contrasting results from these tests with those secured by Schmautz and Zajanc in a fall field planting in Lincoln County (3) throws additional light on the requirements of these species. They planted untreated seeds in September about one-half inch deep (2). Abundant rains in October and heavy snowfall which came early enough to keep the ground from freezing provided the moist, cool conditions necessary for good after-ripening over a period of five or six months.

The following spring emergence for Saskatoon serviceberry, western chokecherry, and Rocky Mountain maple was 29, 38, and 20 percent, respectively. This was about 7, 4, and 10 times as high emergence as obtained with the most successful treatment of these species reported herein. Likely the long after-ripening in the field test was much more conducive to germination of these species than the three-month stratification period used in this study.

The field planting of redosier dogwood, antelope bitterbrush, and snowbrush by Schmautz and Zajanc gave only 11, 18, and 0.12 percent emergence, respectively. In contrast, emergence of these species under the most favorable treatments used in this study was 8, 2, and 83 times as good, respectively. The difference in response of antelope bitterbrush and redosier dogwood in the field as compared to the results reported in this paper was again likely a function of the length of the stratification period. With these species, however, the best after-ripening period was nearer three months than the five or six which appeared to favor the serviceberry, chokecherry, and maple seeds. The long after-ripening period in the fall field planting may have broken the dormancy of the dogwood and bitterbrush seeds before growing conditions were favorable and resulted in the death of many of the seed embryos or small seedlings.

SOME SUGGESTIONS FOR PLANTING BROWSE SEED

Although more needs to be known about seed treatments that will hasten or otherwise control germination of the browse species considered herein, suggestions based on experience gained in this trial and recommendations given in the Woody Plant Seed Manual (4) and other sources may be helpful to those who would plant these species.

Fall planted seeds may be expected to give less consistent results than properly treated spring planted seeds, due to their exacting after-ripening requirements. Whereas, these requirements may be readily met under controlled indoor storage, no such assurance is to be found outdoors where wide fluctuations in soil moisture, temperature, and other factors which could influence after-ripening, are the rule. In addition, fall planting would probably increase the likelihood of rodent damage. Therefore, except as accessibility and other considerations may militate against it, stratification and spring planting are recommended over fall planting.

FOR SPRING PLANTING

1. Reduce impermeability of seed coat of redstem and snowbrush before stratification by soaking the seed in water held near boiling (for 5 to 10 minutes) and then allowing gradual cooling.

2. Stratify each species in fine, moist sand at temperatures of 35 to 41 degrees Fahrenheit for the length of time shown below.

Species	Duration (days)	Species	Duration (days)
Antelope bitterbrush	50-75	Western chokecherry	120-150
Redosier dogwood	90	Rocky Mountain maple	120-150
Redstem ceanothus	90-100	Saskatoon serviceberry	150-180
Snowbrush ceanothus	90-100		

Check the seeds toward the end of the recommended stratification period for beginning of germination. Inspection is particularly needed for the latter three species which may vary between lots as to requirements, and especially of Rocky Mountain maple, the after-ripening requirements of which are poorly understood.

3. Do not allow stratified seeds to dry before field planting.

FOR FALL PLANTING

1. Give redstem and snowbrush the hot water treatment recommended above. Plant other species without seed treatment.

2. Regulate planting time according to the optimum stratification period suggested above. Seeds requiring long stratification such as Saskatoon serviceberry, western chokecherry, and Rocky Mountain maple might logically be planted early. In contrast, redosier dogwood, antelope bitterbrush, redstem, and snowbrush should, if possible, be planted later to help insure that the dormancy period is not broken before conditions are satisfactory for growth.

The above suggestions for both fall and spring planting, although fitting our present state of knowledge, are not the final word. Further progress will be in part dependent upon field planting experience. To maximize the value of field experience maintenance of records on seed origin, treatment, soil, and other environmental conditions of planting site and percent emergence are essential.

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